

Review

The effect of smoke-free homes on adult smoking behavior: A review

Alice L. Mills, Karen Messer, Elizabeth A. Gilpin, & John P. Pierce

Abstract

Introduction: Smoke-free homes are known to reduce exposure to harmful secondhand smoke. Recent studies suggest that they may also positively affect smoking behavior among smokers themselves.

Methods: We review the literature on the effect of smoke-free homes on adult smoking behavior. The literature search included database (PubMed) and manual searches of related articles and reference lists for English-language studies published from 1 January 1990 to 16 November 2008.

Results: We identified 16 cross-sectional and 7 longitudinal studies of the population-level association of smoke-free homes with adult smoking behavior. Additional studies provided population estimates of trends in and correlates of smoke-free homes. Prevalence of smoke-free homes varies but has been increasing over time in the countries studied and was greater among smokers who were younger, of higher income or educational attainment, smoked fewer cigarettes per day, or lived with a nonsmoking adult or child. Both longitudinal and cross-sectional studies showed that smokers who had or who newly implemented a smoke-free home were significantly more likely to make a quit attempt and to be abstinent, after controlling for confounding factors. In longitudinal studies, those who continued to smoke had a modest, but significant, decrease in cigarette consumption at follow-up.

Discussion: There is strong and consistent population-level evidence that a smoke-free home is associated with increased smoking cessation and decreased cigarette consumption in adult smokers. As they not only reduce exposure to secondhand smoke but also increase cessation rates, promotion of smoke-free homes should be a key element in tobacco control programs.

Introduction

There are more than one billion smokers worldwide, and tobacco use kills approximately 5.4 million people a year (World Health Organization, 2008). In the United States, tobacco has been a leading cause of premature death and accounted for an estimated 435,000 deaths in 2000, including deaths from active smoking, deaths from secondhand smoke, and infant deaths due to maternal smoking (Mokdad, Marks, Stroup, & Gerberding, 2004). The most recent study by the Centers for Disease Control and Prevention (CDC; 2008) found that 19.8% of U.S. adults were current smokers in 2007. Of adult everyday smokers, 39.8% reported having stopped smoking for 1 day in the preceding 12 months because they were trying to quit (CDC).

Strategies to improve smoking cessation can be implemented at several levels. On the population level, smoking restrictions in the workplace have been found to not only decrease the exposure of nonsmokers to the harmful effects of secondhand smoke but also positively affect the consumption and cessation rates of smokers (Chapman et al., 1999; Fichtenberg & Glantz, 2002). Recent studies have found that a total smoking restriction at home, that is, a smoke-free home, may have an even stronger association with favorable smoking behavior than do workplace restrictions (Burns, Levinson, Lezotte, & Prochazka, 2007; Farkas, Gilpin, Distefan, & Pierce, 1999; Gilpin & Pierce, 2002; Gilpin, Stillman, Hartman, Gibson, & Pierce, 2000; Lee & Kahende, 2007; Pierce, White, & Messer, 2008; Shavers et al., 2006; Siahpush, Borland, & Scollo, 2003).

In contrast to workplace smoking restrictions, which may be imposed by the law or the employer, smoking restrictions in the home generally need to be by agreement among household adults. An adult smoker may initially desire to implement a smoke-free home to protect the health of non-smoking adults or children in the home or agree to the urging of

Alice L. Mills, M.D., M.P.H., *Cancer Prevention and Control Program, Moores UCSD Cancer Center, University of California, San Diego*

Karen Messer, Ph.D., *Cancer Prevention and Control Program, Moores UCSD Cancer Center, University of California, San Diego*

Elizabeth A. Gilpin, M.S., *Cancer Prevention and Control Program, Moores UCSD Cancer Center, University of California, San Diego*

John P. Pierce, Ph.D., *Cancer Prevention and Control Program, Moores UCSD Cancer Center, University of California, San Diego*

Corresponding Author:

John P. Pierce, Ph.D., *Cancer Prevention and Control Program, Moores UCSD Cancer Center, University of California, 3855 Health Sciences Drive, No. 0901, San Diego, CA 92093-0901, USA. Telephone: 858-822-2380; Fax: 858-822-2399; E-mail: jppierce@ucsd.edu*

doi: 10.1093/ntr/ntp122

Advance Access publication on July 24, 2009

Received February 9, 2009; accepted May 21, 2009

© The Author 2009. Published by Oxford University Press on behalf of the Society for Research on Nicotine and Tobacco.

All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

nonsmoking family members. However, having a smoke-free home creates new barriers to smoking that may lead to changes in smoking behavior and increase the chances for successful cessation.

The presence of a smoke-free home can alter adult smoking behavior in several ways. The smoker may need to alter established patterns, such as forgoing a customary cigarette after a meal, a major relapse situation for many recent quitters (Best & Hakstian, 1978). A smoker living in a smoke-free home must cope with the inconvenience of going outside to smoke, possibly reducing consumption or postponing his or her first cigarette upon awakening. Number of cigarettes smoked per day and smoking the first cigarette within 30 min of awakening are both important indicators of nicotine addiction (Fagerstrom & Schneider, 1989). Thus, implementation of a smoke-free home may disrupt established smoking patterns in a way that may increase the smoker's ability to quit and stay quit. For a smoker who does quit, a smoke-free home may help prevent relapse, as there will be fewer cues from others smoking around them.

If living in a smoke-free home is strongly and independently associated with increased cessation among smokers, then encouraging smokers to implement a smoke-free home may be an effective strategy to increase population cessation rates. The purpose of this study was to review the literature on the association of home smoking restrictions with adult smoking behavior, including relevant background literature on the prevalence and characteristics of smokers with home smoking restrictions.

Methods

We searched PubMed entries dated from 1 January 1990 through 16 November 2008 using the query “(home OR house OR household) AND (rule OR rules OR ban OR bans OR policy OR policies OR smoke free OR smoke-free OR smokefree) AND adult AND smoking” to search all fields. We limited our search to studies involving only adults. This search identified 397 articles (Figure 1). The titles were sufficient to rule out all but 34 of these articles as not population based or otherwise unrelated to our subject. An additional 12 articles were discarded after reading the abstract, and an additional 4 after reading the full text, leaving 18 peer-reviewed articles addressing the topic of the association between home smoking restrictions and adult smoking behavior at the population level. Careful review of the reference lists for these articles led to 2 additional articles that were missed by the original search strategy (Gilpin, Messer, & Pierce, 2006; Shavers et al., 2006). Further query of members of the working group for *IARC Handbook 13* (International Agency for Research on Cancer, in press) on the effectiveness of smoke-free policies (Pierce & Leon, 2008) led to 3 additional references that were in press at the time of the search (Hyland et al., 2009; Messer, Mills, White, & Pierce, 2008; Pierce et al., 2008). Thus, this review considers the evidence from 23 scientific publications that assessed the population-level association between home smoking restrictions and adult smoking behavior (Table 1). During this literature search, we also identified 7 additional studies with cross-sectional estimates of the population prevalence of smoke-free homes.

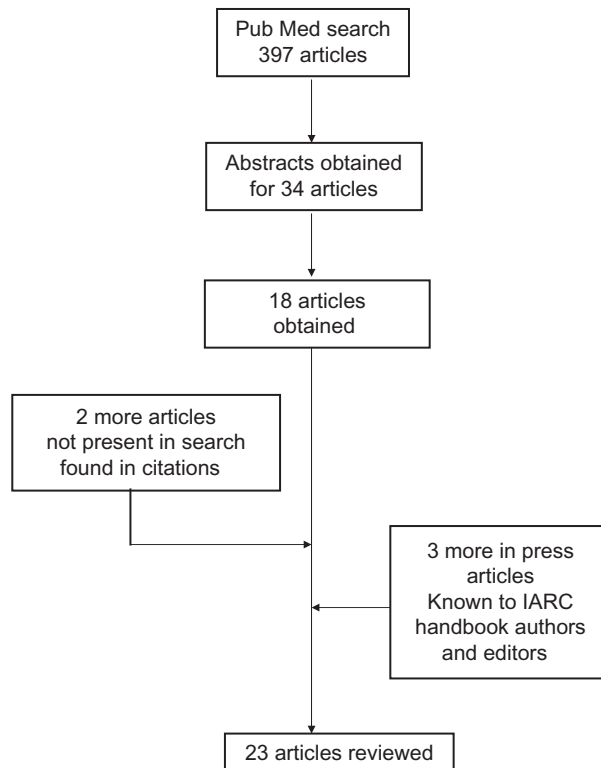


Figure 1. Process of identifying relevant peer-reviewed articles between January 1990 and November 2008.

Results

Data sources used in the literature

Sixteen of the 23 articles on smoke-free homes and smoking behavior presented evidence from cross-sectional population-based surveys (Table 1). Most used data from large, ongoing, government-sponsored publicly available surveys of smoking behavior, including the California Tobacco Survey, the Tobacco Use Supplement to the U.S. Bureau of the Census' Current Population Survey (TUS-CPS), and the Canadian National Population Health Survey (CNPHS). These surveys have relatively high response rates; use state-of-the-art random sampling designs, either sampling telephones using random digit dialing or dwelling units using an area-based list; and weight the survey data to adjust for both the sampling design and the nonresponse so that they are representative of the population from which they are drawn. Two cross-sectional studies that did not use large, ongoing government-sponsored surveys targeted particular ethnic groups and may be less representative (Ji et al., 2005; Shelley, Nguyen, Yerneni, & Fahs, 2008), and a third was a telephone survey conducted by the Gallup organization for the California Department of Public Health (Norman, Ribisl, Howard-Pitney, Howard, & Unger, 2000). The major variables assessed in these cross-sectional studies were current smoke-free home status and recalled quit attempts during the past year for current smokers and duration of abstinence for former smokers.

Seven articles presented evidence from longitudinal follow-up of population-based surveys (Tables 1 and 2). Four of these used longitudinal add-ons to the large publicly available national or

Table 1. Summary of results of studies examining the relationship between home smoking restrictions and adult smoking behavior

		Outcomes					
Study	Locality	Prevalence	Consumption	Cessation			
				Quit attempt	Quit any duration	Reduced relapse	Other
Longitudinal (7 studies)							
Borland et al., 2006	Australia, Canada, United Kingdom, United States		SIG	NS	SIG		
Hyland et al., 2008	United States		NS ^a	SIG	SIG	SIG	
Messer, Mills, et al., 2008	United States		SIG		SIG		
Pierce et al., 1998	California, United States						SIG, progress toward cessation
Pizacani et al., 2004	Oregon, United States			SIG	SIG	SIG	
Shields, 2005	Canada		SIG ^b		NS	SIG	
Shields, 2007	Canada		SIG		SIG		
Cross-sectional (16 studies)							
Burns et al., 2007	Colorado, United States						SIG, duration of smoking
Farkas et al., 1999	United States		SIG	SIG	SIG		
Gilpin et al., 1999	California, United States		SIG	SIG ^c		SIG	SIG, intent to quit
Gilpin et al., 2000	United States	SIG	SIG				
Gilpin et al., 2006	California, United States					SIG	
Gilpin & Pierce, 2002	California, United States		SIG				
Ji et al., 2005	California, United States				SIG		
Lee & Kahende, 2007	United States				SIG		
Messer, Trinidad, et al., 2008	United States			SIG	SIG		
Norman et al., 2000	California, United States		SIG	NS			SIG, desire to quit
Pierce et al., 2008	United States		SIG				
Shavers et al., 2006	United States	SIG	SIG	SIG			
Shelley et al., 2008	New York City, United States		SIG	SIG			
Shopland et al., 2006	United States				SIG		
Siahpush et al., 2003	Australia				SIG		
Tong et al., 2008	California, United States		SIG ^d		SIG		

Note. SIG = significant difference in smoking behavior indicated between smokers with and without home smoking restrictions. All significant differences were in the direction of reduced smoking (i.e., less consumption, more quitting) in homes with restrictions. NS = no significant difference. No entry means that the outcome was not considered.

^aCross-sectional analysis of baseline data.

^bSIG in model without baseline level of addiction.

^cSIG with family preference.

^dSIG in long-term Asian American residents only.

state survey series mentioned previously. The time between the baseline and follow-up interviews was generally 1–2 years, and follow-up participation rates were between 50% and 80%, with extremes of 8 years follow-up and just 23% participation. Two studies did not report follow-up rates (Messer, Mills, et al., 2008; Pierce, Gilpin, & Farkas, 1998). Data are weighted to adjust for both the original sampling design and the loss to follow-up so that they are as representative as possible of the population from which they are drawn. Behavioral outcomes examined in these longitudinal studies were changes between the baseline and follow-up interviews in smoking status and in smoke-free home status, as well as

baseline and follow-up cigarette consumption among continuing smokers.

Measures of smoking behavior

Smoking prevalence

In general, study participants were first classified as ever- or never-smokers, most often using a criterion of lifetime consumption of 100 or more cigarettes, and then ever-smokers were classified as current (daily or someday) or former smokers. Population smoking prevalence was usually estimated by the

percentage of current smokers in the survey sample, appropriately weighted to be representative of the population.

Smoking cessation

Studies differed as to inclusion criteria when estimating population cessation rates—for example, restricting consideration to majority ethnic groups or to daily or heavy (≥ 15 cigarettes/day) smokers. Most cross-sectional studies reporting cessation outcomes consider the proportion abstinent among both current and recent former smokers, that is, among all those reporting smoking within a 1- or 2-year reporting period. To establish duration of abstinence, former smokers were asked to provide the date when they quit, or else the number of days or a general time interval since they last smoked (e.g., < 3 months, 3–6 months, 6–12 months), which could be defined as “last smoked regularly” or “last smoked, even a single puff.” Current smokers were asked if they had tried to quit (usually for a day or longer) at least once in the past year and, in some studies, if they had future intentions to quit.

Home smoking restrictions

The questions assessing home smoking restrictions varied from study to study. A smoke-free home might be defined by agreement with “no one is allowed to smoke anywhere inside the home” or in some cross-sectional surveys by “no one smoked inside the home in the past week.” The first definition focuses on rule making in the home, whereas the latter definition focuses on recent behavior. This will lead to different denominators in different studies (e.g., some houses without smokers make rules and others do not). The CNPHS asks whether “no one smokes regularly inside the home.” A further complication is that studies differed in the comparison groups that they used. Some compared full smoking bans with anything else, whereas others combined a partial or full ban and compared this group with houses with no restrictions. The chance of finding an association or an effect may be diminished by these methodological differences.

Consumption

Self-reported cigarette consumption for daily smokers was usually ascertained by asking the average number of cigarettes smoked per day and for someday smokers by asking how many days per month they smoke and on days they do smoke, about how many cigarettes are consumed. Note that cross-sectional studies cannot accurately assess the number of cigarettes per day in former smokers due to recall bias; the number of minutes to smoking the first cigarette of the day is a more reliable measure of recalled addiction level (Messer, Trinidad, Al-Delaimy, & Pierce, 2008; Zhu, Sun, Hawkins, Pierce, & Cummins, 2003).

Prevalence of smoke-free homes among current smokers

The prevalence of smoke-free homes among smokers was seen to be increasing rapidly over time in those jurisdictions with repeated cross-sectional surveys (Table 2). For example, in the United States, the CDC reported that fewer than 10% of smokers had a smoke-free home in 1992–1993 but that this increased threefold over the decade to 31.8% by 2003 (CDC, 2007). A similar trend was also seen in other countries with tobacco control programs (Borland, Mullins, Trotter, & White, 1999; Lund & Lindbak, 2007).

At any given point in time, the prevalence of smoke-free homes among smokers differed widely among developed countries, as is expected from the theory of how innovations diffuse

through societies (Rogers, 1962, 2003; Table 2). For example, Borland et al. (2006) compared the prevalence of home smoking restrictions among smokers in Australia, Canada, the United Kingdom, and the United States in 2003. Australian smokers had the highest prevalence of smoke-free homes (43.1%), followed by Canada (31.5%), the United States (27.9%), and the United Kingdom (19.0%). The earliest reported prevalence of smoke-free homes across the U.S. states was for the years 1992–1993 (Gilpin et al., 2000). Here, there was a more than threefold difference across states, from a high of 42.2% in Utah to a low of 12.5% in Kentucky. Interestingly, relative differences are less when prevalence is considered among nonsmokers and smokers together, as nonsmokers are much more likely to have a smoke-free home. In 2003, the prevalence of smoke-free homes among the total adult population ranged from 53.4% of all households in Kentucky to 88.8% of all households in Utah (CDC, 2007).

Characteristics of smokers with smoke-free homes

A large number of studies have consistently found that current smokers with lower cigarette consumption are considerably more likely to report a smoke-free home (Borland et al., 2006; Farkas et al., 1999; Gilpin & Pierce, 2002; Gilpin, White, Farkas, & Pierce, 1999; Hyland et al., 2008; Messer, Mills, et al., 2008; Norman et al., 2000; Pierce et al., 2008; Pizacani et al., 2004; Shelley et al., 2008; Shields, 2005, 2007; Tong, Nguyen, Vittinghoff, & Perez-Stable, 2008). Four of the 7 longitudinal studies presented here found a significant association between lower cigarette consumption and report of a smoke-free home (Borland et al., 2006; Messer, Mills, et al.; Shields, 2005, 2007), whereas 1 study found no significant association (Hyland et al., 2008) and 3 did not consider this variable. Nine of the 16 cross-sectional studies presented here found a significant association between lower consumption level and report of a smoke-free home, whereas the remaining 7 studies did not consider this particular measure.

A smoke-free home was more commonly reported among current smokers with no other smoker in the household (Hyland et al., 2008) and those with children (Borland et al., 2006; Gilpin et al., 1999; Merom & Rissel, 2001; Norman, Ribisl, Howard-Pitney, & Howard, 1999; Okah, Choi, Okuyemi, & Ahluwalia, 2002; Pizacani et al., 2004; Shields, 2007) or non-smoking adults in the home (Borland et al., 2006; Gilpin et al., 1999; Okah et al., 2002, 2003; Pizacani et al., 2004).

Smokers are also somewhat more likely to report a smoke-free home if they are male (Gilpin et al., 1999; Hyland et al., 2008; Merom & Rissel, 2001; Shields, 2007), younger in age (Borland et al., 2006; Gilpin et al.; Merom & Rissel, 2001; Messer, Mills, et al., 2008; Norman et al., 2000; Pierce et al., 2009; Pizacani et al., 2004; Shields), higher in income (Hyland et al.; Pizacani et al., 2004; Shavers et al., 2006) or years of formal education (Merom & Rissel; Pizacani et al.; Shields), or married (Pizacani et al.). Some studies reported that racial/ethnic groups differ in the prevalence of smoke-free homes, which may be associated with differences in average consumption levels and other factors. Gilpin et al. found that Hispanic and Asian smokers in California were significantly more likely than Whites to have a smoke-free home, whereas Blacks were less likely. Norman et al. noted similar findings, although the result was not statistically significant for Hispanics, perhaps due to smaller sample sizes.

Table 2. Population prevalence of smoke-free homes among smokers

Study	Locality	Sample size	Year	Prevalence %	
<i>Attitudes of Europeans Towards Tobacco—Report, 2007</i>	25 European Union countries and three other European countries	Survey conducted by the Directorate-General Health and Consumer Protection of the European Commission	Answer “no” to: Do you smoke inside your home when you are alone?	Mean 18%; range 7%–67%; six countries ≥30%; eight countries ≤15% (answered “no” to the question)	
Al-Delaimy et al., 2008	California (United States)	California Tobacco Survey (adult smokers)			
		4,558	1992	19.4	
		8,581	1996	35.9	
		5,470	1999	46.8	
		5,278	2002	51.9	
Ashley et al., 1998	Canada	3,821	2005	57.8	
		443 adult smokers	1996	14.4	
		800–900 adult smokers/survey year	1995	20.0	
Borland et al., 1999	Victoria, Australia		1996	23.5	
			1997	28.0	
			2002	31.5 (Canada); 27.9 (United States); 19.0 (United Kingdom); 43.1 (Australia)	
Borland et al., 2006	Canada, United States, United Kingdom, and Australia	9,046 adult smokers in 4 countries	2002		
				Ireland	United Kingdom
				15	18
Fong et al., 2006	Ireland and United Kingdom	Adults surveyed before ($n = 1,679$) and after ($n = 1,185$) law banning smoking in public places	2003–2004	20	
			2004–2005	24	
Gillespie, Milne, & Wilson, 2005	New Zealand	1,507 adult current smokers	2004	52.8 (smokers who do not smoke indoors at home)	
Lund & Lindbak, 2007	Norway	Annual surveys		Occasional	Daily
			1995	26	10
			1996	26	12
			1997	45	20
			1998	52	21
			1999	46	19
			2000	49	24
			2001	53	26
			2002	66	25
			2003	64	42
			2004	75	43
			2005	80	58
McMillen, Winickoff, Klein, & Weitzman, 2003	United States	362 and 669 smokers	2001	28.5	
			2002	30.2	
			1992–1993	9.6	
CDC, 2007	United States	Current Population Survey: smokers aged ≥15 years	2003	31.8	
			1996–1997	43.3	
			1997	30.4	

Characteristics of a smoker's peer group may also be associated with home restrictions. Norman et al. (2000) found that smokers with no or few friends who smoke were significantly more likely to have a smoke-free home than those with most friends who smoke; however, Okah et al. (2002) did not see an association with best friends' smoking status. In some studies, a smoker's beliefs and attitudes toward secondhand smoke were relevant: Smokers with knowledge of or belief in the harmfulness of environmental tobacco smoke (ETS; Gilpin et al., 1999; Pizacani et al., 2004; Shelley et al., 2008) were more likely to have a smoke-free home, as were smokers who support bans in public venues (Borland et al., 2006). Finally, a few studies have found that a smoker's intention to quit may be associated with

the presence of home smoking restrictions (Okah et al., 2003; Pizacani et al., 2004; Shields, 2007).

Smoke-free homes and quitting (cross-sectional studies)

Table 1 presents the main findings of all 23 studies addressing the effect of home smoking restrictions on smoking behavior. This subsection summarizes the cross-sectional studies, which have consistently found that recent smokers (defined as current and recent former smokers) with smoke-free homes were more likely to have made a quit attempt within the past year (Farkas et al., 1999; Gilpin et al., 1999; Messer, Trinidad, et al., 2008;

Shavers et al., 2006; Shelley et al., 2008) and to be abstinent when interviewed for 3+ months (Burns et al., 2007; Ji et al., 2005; Shopland, Anderson, & Burns, 2006), 6+ months (Farkas et al., 1999; Messer, Trinidad, et al., 2008), 7–24 months (Lee & Kahende, 2007), or 1–2 years (Siahpush et al., 2003). All these studies adjusted for demographic factors such as gender, age, race/ethnicity, and education. Two of these studies (Messer, Trinidad, et al., 2008; Shelley et al., 2008) adjusted for recalled cigarette consumption or addiction level, and 3 (Farkas et al., 1999; Gilpin et al., 1999; Shelley et al., 2008) adjusted for household composition (i.e., presence of nonsmoking adults or children).

Interestingly, Gilpin et al. (1999) showed that a smoke-free home plus a family preference that the smoker not smoke was significantly associated with both a past-year quit attempt and an intention to quit in the next 6 months; however, a smoke-free home without such a family preference was associated with neither. Norman et al. (2000) found that smokers with a smoke-free home were significantly more likely to be interested in quitting, and Messer, Trinidad, et al. (2008) noted that smokers with a smoke-free home were more likely to have at least “seriously tried” to quit in the past year as well as to have made a quit attempt.

Several studies used a survival analysis to compare duration of abstinence among those who reported a quit attempt within the past year. In these analyses, smokers still abstinent at interview are considered to be censored. Gilpin et al. (1999) found that among California smokers who reported a quit attempt within the past year, those living in a smoke-free home reported a significantly longer period of abstinence than those living under partial or no home restrictions (Table 1). In a similar analysis using only heavy smokers (15+ cigarettes/day), Gilpin et al. (2006) found that a smoke-free home significantly prolonged duration of abstinence, while adjusting for presence of another smoker in the house, use of pharmaceutical aids, consumption level, and demographics. Interestingly, in this analysis, use of pharmaceutical aids appeared to have a longer term benefit only when the home was smoke free. Pizacani et al. (2004) found that the effect of a smoke-free home on duration of abstinence varied by intention to quit (stages of change model); a smoke-free home at baseline was associated with longer duration only for smokers in the preparation stage (Supplementary Table 1).

Smoke-free homes and future smoking cessation (longitudinal studies)

Supplementary Table 1 describes the results of the seven longitudinal studies in detail. Most longitudinal studies have found a significant association between presence of a smoke-free home at baseline and future quitting behavior. Messer, Mills, et al. (2008) analyzed national data from an overlap sample within the 2002 and 2003 TUS-CPS and found that a smoke-free home among baseline smokers significantly increased the probability of abstinence at follow-up (odds ratio [OR] = 1.52, 95% CI = 1.08–2.15). In a 2005 follow-up survey of Community Intervention Trial for Smoking Cessation study participants (a large randomized trial of smoking cessation among heavy smokers from the United States and Canada that enrolled in the late 1980s), Hyland et al. (2009) noted that those with a smoke-free home at baseline were more likely to make a quit attempt (relative risk [RR] = 1.5, 95% CI = 1.3–1.9) and more likely to be abstinent at long-term follow-up

(RR = 1.7, 95% CI = 1.4–2.2) compared with smokers who lived in homes where smoking was allowed at both surveys. Pierce et al. (1998) reported on a quitting continuum and noted that smokers with a smoke-free home appeared closer to successful quitting than smokers without home restrictions who did not believe ETS was harmful. In a study of Oregon smokers, Pizacani et al. (2004) found that association of a smoke-free home with 7+ days of abstinence at follow-up varied by intention to quit, with the largest positive association seen in those in the preparation stage of the stages of change model. These studies accounted for baseline cigarette consumption, and the majority, except for Pierce et al. and Pizacani et al., adjusted for presence of another smoker in the household. In contrast to this group of studies showing significant associations between home bans and quitting behavior, Shields (2005) did not find the association of smoke-free homes with quitting to be significant after adjustment for other variables, including consumption level and household composition.

Only two longitudinal studies specifically studied the association between adoption of a newly smoke-free home and changes in smoking behavior at final follow-up (Messer, Mills, et al., 2008; Shields, 2007; Supplementary Table 1). Shields used pooled observations from 1994–2005 series of CNPHS to select smokers without a smoke-free home at baseline who continued to smoke at first follow-up (2 years later). She compared the quit rates at second follow-up (4 years after baseline). Among baseline smokers who had adopted a smoke-free home at first follow-up, 20% had quit at second follow-up, as compared with only 13% of those who continued to live in homes that were not smoke free. This effect of a smoke-free home was statistically significant in a logistic regression model adjusted for consumption level, household composition, and other demographic factors (adjusted OR (AOR) = 1.6, 95% CI = 1.3–2.1). Messer, Mills, et al. compared outcomes among baseline smokers with no smoke-free home. A smoke-free home at 12-month follow-up was associated with increased probability of abstinence by almost fourfold (AOR = 3.89, 95% CI = 2.55–5.87) and the probability of at least 90-day abstinence by almost fivefold (AOR = 4.81, 95% CI = 3.06–7.59), in a logistic regression model adjusted for baseline consumption level, household composition, and demographic variables.

Two longitudinal studies examined the effect of a continuing smoke-free home (assessed at baseline and follow-up; Borland et al., 2006; Messer, Mills, et al., 2008). In 2006, Borland et al. used the International Tobacco Control Four Country Survey (see Supplementary Table 1) to compare smokers with a smoke-free home both at baseline (2002) and at 6–12 month follow-up with those with no smoke-free home at either survey. Smokers with a smoke-free home at both surveys had increased odds of a quit attempt (OR = 1.32, 95% CI = 1.1–1.57) and of abstinence of 1 month or more (OR = 2.50, 95% CI = 1.50–4.16), compared with those smokers with no home ban at either survey. The analysis adjusted for demographic variables and household composition but did not adjust for baseline cigarette consumption. The effect on quit attempts disappeared when addiction level or daily versus nondaily smoking was included in the model; however, the effect on abstinence remained significant. Considering only smokers with a smoke-free home at baseline, Messer, Mills, et al. found that those who maintained the smoke-free home at 1-year follow-up had an increased likelihood of abstinence (OR = 2.10, 95% CI = 1.09–4.04) and of 90+ days of abstinence (OR = 1.99, 95% CI = 0.93–4.25), as

compared with those who no longer had a smoke-free home at follow-up. This study adjusted for demographic variables and baseline cigarette consumption but not for household composition.

Smoke-free homes and relapse among former smokers (longitudinal studies)

Hyland et al. (2008) found that among former smokers in 2001, those with a smoke-free home at baseline were less likely to be smoking in 2005 compared with those who allowed smoking in their homes ($OR = 0.6$, 95% $CI = 0.4-0.8$). In a longitudinal study of Oregon smokers, Pizacani et al. (2004) found that the effect of a smoke-free home on relapse rate varied by intention to quit (stages of change model); a smoke-free home at baseline was associated with a lower relapse rate only for smokers in the preparation stage (Supplementary Table 1). Shields (2005) examined longitudinal data from CNPHS and found different effects of smoke-free homes on relapse rates in men compared with women: Men living in smoke-free homes had lower odds of relapsing than men living in homes where smoking was allowed; however, a smoke-free home was not related to relapse for women.

Smoke-free homes and continuing smokers (cross-sectional and longitudinal studies)

Cross-sectional and longitudinal studies have found a positive association of smoke-free homes on smoking behavior even in smokers who continue to smoke. Shelley et al. (2008) found that smokers living in a smoke-free home were more likely to delay smoking more than 30 min, a measure of nicotine dependence. Using a cross-sectional sample of California smokers, Gilpin et al. (1999) compared reported cigarette consumption 1 year prior to the survey with current consumption. The authors found that smokers with a home ban had a 13% decrease in cigarettes per day compared with only a 5% decrease in smokers who did not report a home ban.

Three longitudinal studies found similar estimates of decreased consumption among smokers who implemented a smoke-free home (Borland et al., 2006; Messer, Mills, et al., 2008; Shields, 2007). Borland et al. noted that smokers who implemented a smoke-free home reported a 1.9 cigarette/day reduction in daily consumption and an increase of 31.3 min in time to first cigarette of the day. In a 2007 longitudinal analysis of Canadian smokers, Shields found that among daily smokers who did not live in a smoke-free home at baseline, those who had implemented a smoke-free home at 2-year follow-up decreased consumption by an average of 2.0 cigarettes/day, compared with a drop of only 0.4 cigarettes/day in those who had not implemented a smoke-free home. Similarly, a longitudinal study of smokers in the United States found that among continuing smokers without a smoke-free home at baseline, adoption of a smoke-free home was associated with a significant average decline in consumption of 2.18 (95% $CI = 1.24-3.10$) cigarettes/day, and the decline was noted among heavier as well as lighter smokers (Messer, Mills, et al.).

Partial home smoking restrictions

Burns et al. (2007) and Shopland et al. (2006) found an increased likelihood of quitting in smokers with increasing level of home smoking restrictions. Gilpin et al. (1999) found no effect of partial restrictions on delay of smoking upon awakening, but a

smoke-free home was highly associated with this indicator of nicotine dependence. Borland et al. (2006) found no positive association between partial restrictions and quit attempts or an abstinence of 1+ months (although there were significantly higher rates in those who maintained a smoke-free home).

Discussion

Population studies of smoking behavior consistently show that smokers who live in a smoke-free home are more likely to have made a quit attempt and to remain abstinent than smokers who do not live with a total home smoking ban. Three large longitudinal studies show that a smoke-free home is consistently associated with a 50%–70% increase in the odds of abstinence at follow-up, even after adjusting for consumption level and other factors and even among heavier smokers (Hyland et al., 2009; Messer, Mills, et al., 2008; Shields, 2007). Longitudinal studies also consistently show that continuing smokers who live in a smoke-free home have modest but significant reductions in consumption over time, smoking an average of about two cigarettes/day less at 1-year follow-up. This estimated drop in consumption was consistent across three major longitudinal studies in different countries. Studies consistently found that while complete home smoking bans appeared to be beneficial, partial home smoking restrictions showed little or no effect.

Cross-sectional and longitudinal studies consistently showed that smokers with lighter consumption or longer time to first cigarette were much more likely to have or to adopt a smoke-free home. The estimated decrease in consumption associated with adoption of a smoke-free home was modest in size and cannot account for these differences. As smokers with lower levels of dependence are also much more likely to quit (Farkas et al., 1996; Zhou et al., 2009), it is important to control for addiction level when studying the association between smoke-free homes and smoking cessation.

Presence of one or more nonsmokers in the same household, particularly children, was strongly associated with presence of a smoke-free home, even after adjusting for confounders. In related results, one longitudinal study asked whether there was a family preference that the smoker quit smoking. In this study, a smoke-free home together with family pressure to quit, but neither factor in the absence of the other, predicted abstinence at follow-up (Gilpin et al., 1999). Another study showed that use of pharmaceutical cessation aids showed no long-term effect unless there was also a smoke-free home, whether or not there was another smoker in the house (Gilpin et al., 2006). These results suggest that a smoke-free home may be an effective aid in implementing a successful cessation strategy and that motivation to quit may be an independent factor.

The advantages of the population-level studies that we reviewed are that they are able to assess broad associations across a representative group of smokers and to estimate population-level impacts. Data sources include the major national surveys designed to provide population-level surveillance of smoking behavior, such as the TUS-CPS and the CNPHS. These surveys are designed to compensate for the tendency of some demographic groups to have lower participation rates and, in longitudinal series, to drop out before final follow-up.

A possible limitation of these studies is that, as with most studies, they rely on self-reported smoking behavior. Numerous

studies have demonstrated the validity of this approach in assessing smoking status in population surveys (Gilpin et al., 1994; Gilpin, Pierce, & Farkas, 1997; Pierce et al., 1987; Velicer, Prochaska, Rossi, & Snow, 1992). Nonetheless, recalled cessation history is limited by recall bias. Smokers are more likely to forget short quit attempts or more distant quit attempts (Gilpin et al., 1994), and most studies limited assessment to asking about quitting within the past year. Further, there is no indication that this bias would differ between smokers with and without smoke-free homes so that relative comparisons of recalled quitting would remain valid. A second limitation of many studies is that the timing of the implementation of the smoke-free home and of any quit attempt cannot be established. If a smoker in a quit attempt who has a home smoking ban and then relapses is likely to rescind the ban upon relapse, this will exaggerate the cross-sectional association between smoke-free homes and abstinence, although prospective studies can provide additional evidence on timing. Having a smoke-free home is self-reported, and Mumford, Levy, and Romano (2004) examined consistency of reported home smoking restrictions between members of the same household in the 1989–1999 TUS-CPS. They found that 12% of sample households provided inconsistent reports about home smoking bans and that households with a current smoker were more likely to be discrepant. Similarly, in one of the cross-sectional studies included in this review (Gilpin et al., 1999), home smoking status reported by adults in the same household was concordant in 82% of cases and among the discrepant responses; most often the smoker reported no restriction, whereas someone else reported a restriction existed. In this case, it is likely that the smoker neither acknowledged nor abided by the smoking restrictions, increasing the validity of self-reported bans among smokers. Further research is needed on the validity of self-report of home smoking restrictions and how invalid reports might bias the findings of studies such as those reviewed here.

The cross-sectional studies we report provide strong evidence of population-level associations between presence of a smoke-free home, lower cigarette consumption levels, and higher prevalence of quitting behaviors. However, these associations are consistent with several different possible causal mechanisms. For example, a smoker with a smoke-free home may consume fewer cigarettes because (a) a smoke-free home makes it inconvenient to smoke and causes a reduction in consumption, (b) a smoker who is less addicted is more likely to agree to a smoke-free home, and (c) a smoker whose family dislikes smoking is likely to not only cut down on cigarettes but also implement a smoke-free home. In fact, all three causal pathways may be in effect and responsible for some of the observed cross-sectional association between lighter consumption levels and smoke-free homes. The longitudinal studies we report can establish the timing of an association, distinguishing between (a) and (b) above and strengthening the evidence for a cause-and-effect relationship. However, a prospective association, such as between a smoke-free home at baseline and abstinence at follow-up, may still be because of a common reaction to a third factor—for example, presence of family members who dislike smoking. Another limitation of the longitudinal studies is that the sample sizes may be smaller than in cross-sectional studies and a significant percentage of the subjects may be lost to follow-up. If the group lost differs in some important respect (e.g., propensity to quit) from the group successfully followed, the study results can be biased, although weighting can adjust for such bias to some extent.

Finally, several researchers examined the same series of publicly available high-quality population surveys, although using different years, and many survey questions shared wording across important tobacco-use questions. The consistency of results reported across multiple surveys and years is an important source of objective validity. However, a limitation is that the questions regarding home smoking restrictions were less standardized and that different lengths of abstinence were considered in different studies. Despite any differences, reported effect sizes were remarkably consistent across the longitudinal studies. A more important limitation is the relatively small number of population-level longitudinal surveillance series of smoking behavior that are publicly available.

Recent reports using high-quality population-level survey data indicate an increasing trend in the prevalence of smoke-free homes among smokers in the United States and around the world. This is encouraging news considering the well-known negative health effects of secondhand smoke (U.S. Department of Health and Human Services, 2006). In addition to decreasing the harm to nonsmoking children and adults, this review of the literature finds strong and consistent population-level evidence that a smoke-free home is associated with increased smoking cessation among adult smokers. Such evidence can be obtained only with high-quality population-level surveillance of tobacco-use behavior, and there is a need for additional longitudinal studies of smoke-free homes and smoking behavior using such survey data. Ideally, future studies should include factors that appear to be related to having a smoke-free home and also to smoking cessation, particularly education, age, gender, race/ethnicity, cigarette consumption level, and household composition. An additional step would be to incorporate adoption of a smoke-free home into smoking cessation trials, both alone and in combination with other cessation modalities. Future research should also help identify receptive population segments (e.g., lighter smokers, smokers with young children) and investigate effective ways to promote smoke-free homes among such smokers through media campaigns or health care providers. To fully utilize the potential of smoke-free homes as a cessation strategy, approaches also need to be identified for the heavy smoker who lives alone or only with other smokers.

Supplementary material

Supplementary Table 1 can be found at *Nicotine & Tobacco Research* online (<http://www.ntr.oxfordjournals.org/>).

Funding

Preparation of this article was supported by the Tobacco-Related Disease Research Program Grant 15RT-0238 from the University of California.

Declaration of Interests

None declared.

Acknowledgments

Some of the work for this review was undertaken by one of the authors (EAG) as part of the preparation of a chapter for a handbook on smoke-free policies for the International Agency for Research on Cancer (in press).

References

- Al-Delaimy, W. K., White, M. M., Trinidad, D. R., Messer, K., Mills, A. L., & Pierce, J. P. (2008). *The California Tobacco Control Program: Can we maintain the progress? Results from the California Tobacco Survey, 1990–2005* (Vol. 2). La Jolla, CA: University of California, San Diego.
- Ashley, M. J., Cohen, J., Ferrence, R., Bull, S., Bondy, S., Poland, B., et al. (1998). Smoking in the home: Changing attitudes and current practices. *American Journal of Public Health, 88*, 797–800.
- Attitudes of Europeans Towards Tobacco—Report*. (2007, May). Special Eurobarometer. 272c/Wave 66.2-TNS Opinion & Social. European Commission. Retrieved 28 January 2009, from http://ec.europa.eu/public_opinion/archives/eb_special_en.htm
- Best, J. A., & Hakstian, A. R. (1978). A situation-specific model for smoking behavior. *Addictive Behavior, 3*, 79–92.
- Borland, R., Mullins, R., Trotter, L., & White, V. (1999). Trends in environmental tobacco smoke restrictions in the home in Victoria, Australia. *Tobacco Control, 8*, 266–271.
- Borland, R., Yong, H. H., Cummings, K. M., Hyland, A., Anderson, S., & Fong, G. T. (2006). Determinants and consequences of smoke-free homes: Findings from the International Tobacco Control (ITC) Four Country Survey. *Tobacco Control, 15*(Suppl. 3), iii42–iii50.
- Burns, E. K., Levinson, A. H., Lezotte, D., & Prochazka, A. V. (2007). Differences in smoking duration between Latinos and Anglos. *Nicotine & Tobacco Research, 9*, 731–737.
- Centers for Disease Control and Prevention. (2007). State-specific prevalence of smoke-free home rules—United States, 1992–2003. *MMWR—Morbidity & Mortality Weekly Report, 56*, 501–504.
- Centers for Disease Control and Prevention. (2008). Cigarette smoking among adults—United States, 2007. *MMWR—Morbidity & Mortality Weekly Report, 57*, 1221–1226.
- Chapman, S., Borland, R., Scollo, M., Brownson, R. C., Dominello, A., & Woodward, S. (1999). The impact of smoke-free workplaces on declining cigarette consumption in Australia and the United States. *American Journal of Public Health, 89*, 1018–1023.
- Fagerstrom, K. O., & Schneider, N. G. (1989). Measuring nicotine dependence: A review of the Fagerstrom Tolerance Questionnaire. *Journal of Behavioral Medicine, 12*, 159–182.
- Farkas, A. J., Gilpin, E. A., Distefan, J. M., & Pierce, J. P. (1999). The effects of household and workplace smoking restrictions on quitting behaviours. *Tobacco Control, 8*, 261–265.
- Farkas, A. J., Pierce, J. P., Zhu, S. H., Rosbrook, B., Gilpin, E. A., Berry, C., et al. (1996). Addiction versus stages of change models in predicting smoking cessation. *Addiction, 91*, 1271–1280. discussion 1281–1292.
- Fichtenberg, C. M., & Glantz, S. A. (2002). Effect of smoke-free workplaces on smoking behaviour: Systematic review. *British Medical Journal, 325*, 188.
- Fong, G. T., Hyland, A., Borland, R., Hammond, D., Hastings, G., McNeill, A., et al. (2006). Reductions in tobacco smoke pollution and increases in support for smoke-free public places following the implementation of comprehensive smoke-free workplace legislation in the Republic of Ireland: Findings from the ITC Ireland/UK Survey. *Tobacco Control, 15*(Suppl. 3), iii51–iii58.
- Gillespie, J., Milne, K., & Wilson, N. (2005). Secondhand smoke in New Zealand homes and cars: Exposure, attitudes, and behaviours in 2004. *New Zealand Medical Journal, 118*, U1782.
- Gilpin, E. A., Messer, K., & Pierce, J. P. (2006). Population effectiveness of pharmaceutical aids for smoking cessation: What is associated with increased success? *Nicotine & Tobacco Research, 8*, 661–669.
- Gilpin, E. A., & Pierce, J. P. (2002). The California Tobacco Control Program and potential harm reduction through reduced cigarette consumption in continuing smokers. *Nicotine & Tobacco Research, 4*(Suppl. 2), S157–S166.
- Gilpin, E. A., Pierce, J. P., Cavin, S. W., Berry, C. C., Evans, N. J., Johnson, M., et al. (1994). Estimates of population smoking prevalence: Self-vs proxy reports of smoking status. *American Journal of Public Health, 84*, 1576–1579.
- Gilpin, E. A., Pierce, J. P., & Farkas, A. J. (1997). Duration of smoking abstinence and success in quitting. *Journal of the National Cancer Institute, 89*, 572–576.
- Gilpin, E. A., Stillman, F. A., Hartman, A. M., Gibson, J. T., & Pierce, J. P. (2000). Index for US state tobacco control initial outcomes. *American Journal of Epidemiology, 152*, 727–738.
- Gilpin, E. A., White, M. M., Farkas, A. J., & Pierce, J. P. (1999). Home smoking restrictions: Which smokers have them and how they are associated with smoking behavior. *Nicotine & Tobacco Research, 1*, 153–162.
- Hyland, A., Higbee, C., Hassan, L., Fong, G. T., Borland, R., Cummings, K. M., et al. (2008). Does smoke-free Ireland have more smoking inside the home and less in pubs than the United Kingdom? Findings from the international tobacco control policy evaluation project. *European Journal of Public Health, 18*, 63–65.
- Hyland, A., Higbee, C., Travers, M., Van Deusen, A., Bansal-Travers, M., King, B., et al. (2009). Smoke-free homes and smoking cessation and relapse in a longitudinal population of adults. *Nicotine & Tobacco Research, 11*, 614–618.
- International Agency for Research on Cancer. (in press). *IARC handbooks of cancer prevention, tobacco control: Vol. 13: Evaluating the effectiveness of smoke-free policies*. Lyon, France: Author.

- Ji, M., Hofstetter, C. R., Hovell, M., Irvin, V., Song, Y. J., Lee, J., et al. (2005). Smoking cessation patterns and predictors among adult Californians of Korean descent. *Nicotine & Tobacco Research*, 7, 59–69.
- Lee, C. W., & Kahende, J. (2007). Factors associated with successful smoking cessation in the United States, 2000. *American Journal of Public Health*, 97, 1503–1509.
- Lund, M., & Lindbak, R. (2007). *Norwegian Tobacco Statistics, 1973–2006*. Norwegian Institute for Alcohol and Drug Research (SIRUS) Retrieved January 29, 2009, from Web site: <http://www.sirus.no/internett/tobakk/publication/386.html>
- McMillen, R. C., Winickoff, J. P., Klein, J. D., & Weitzman, M. (2003). US adult attitudes and practices regarding smoking restrictions and child exposure to environmental tobacco smoke: Changes in the social climate from 2000–2001. *Pediatrics*, 112(Pt. 1), e55–e60.
- Merom, D., & Rissel, C. (2001). Factors associated with smoke-free homes in NSW: Results from the 1998 NSW Health Survey. *Australian and New Zealand Journal of Public Health*, 25, 339–345.
- Messer, K., Mills, A. L., White, M. M., & Pierce, J. P. (2008). The effect of smoke-free homes on smoking behavior in the United States. *American Journal of Preventive Medicine*, 35, 210–216.
- Messer, K., Trinidad, D. R., Al-Delaimy, W. K., & Pierce, J. P. (2008). Smoking cessation rates in the United States: A comparison of young adult and older smokers. *American Journal of Public Health*, 98, 317–322.
- Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. *Journal of the American Medical Association*, 291, 1238–1245.
- Mumford, E. A., Levy, D. T., & Romano, E. O. (2004). Home smoking restrictions. Problems in classification. *American Journal of Preventive Medicine*, 27, 126–131.
- Norman, G. J., Ribisl, K. M., Howard-Pitney, B., & Howard, K. A. (1999). Smoking bans in the home and car: Do those who really need them have them? *Preventive Medicine*, 29, 581–589.
- Norman, G. J., Ribisl, K. M., Howard-Pitney, B., Howard, K. A., & Unger, J. B. (2000). The relationship between home smoking bans and exposure to state tobacco control efforts and smoking behaviors. *American Journal of Health Promotion*, 15, 81–88.
- Okah, F. A., Choi, W. S., Okuyemi, K. S., & Ahluwalia, J. S. (2002). Effect of children on home smoking restriction by inner-city smokers. *Pediatrics*, 109, 244–249.
- Okah, F. A., Okuyemi, K. S., McCarter, K. S., Harris, K. J., Catley, D., Kaur, H., et al. (2003). Predicting adoption of home smoking restriction by inner-city black smokers. *Archives of Pediatrics & Adolescent Medicine*, 157, 1202–1205.
- Pierce, J. P., Dwyer, T., DiGiusto, E., Carpenter, T., Hannam, C., Amin, A., et al. (1987). Cotinine validation of self-reported smoking in commercially run community surveys. *Journal of Chronic Diseases*, 40, 689–695.
- Pierce, J. P., Gilpin, E. A., & Farkas, A. J. (1998). Can strategies used by statewide tobacco control programs help smokers make progress in quitting? *Cancer Epidemiology Biomarkers & Prevention*, 7, 459–464.
- Pierce, J. P., & Leon, M. E., for the IARC Handbook Volume 13 Working Group and IARC Secretariat. (2008). Effectiveness of smoke-free policies. *Lancet Oncology*, 9, 614–615.
- Pierce, J. P., White, M. M., & Messer, K. (2009). Changing age-specific patterns of cigarette consumption in the United States, 1992–2002: Association with smoke-free homes and state level of tobacco control activity. *Nicotine & Tobacco Research*, 11, 171–177.
- Pizacani, B. A., Martin, D. P., Stark, M. J., Koepsell, T. D., Thompson, B., & Diehr, P. (2003). Household smoking bans: Which households have them and do they work? *Preventive Medicine*, 36, 99–107.
- Pizacani, B. A., Martin, D. P., Stark, M. J., Koepsell, T. D., Thompson, B., & Diehr, P. (2004). A prospective study of household smoking bans and subsequent cessation related behaviour: The role of stage of change. *Tobacco Control*, 13, 23–28.
- Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press.
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
- Shavers, V. L., Fagan, P., Alexander, L. A., Clayton, R., Doucet, J., & Baezconde-Garbanati, L. (2006). Workplace and home smoking restrictions and racial/ethnic variation in the prevalence and intensity of current cigarette smoking among women by poverty status, TUS-CPS 1998–1999 and 2001–2002. *Journal of Epidemiology & Community Health*, 60 (Suppl. 2), 34–43.
- Shelley, D., Nguyen, N., Yerneni, R., & Fahs, M. (2008). Tobacco use behaviors and household smoking bans among Chinese Americans. *American Journal of Health Promotion*, 22, 168–175.
- Shields, M. (2005). The journey to quitting smoking. *Health Reports*, 16, 19–36.
- Shields, M. (2007). Smoking bans: Influence on smoking prevalence. *Health Reports*, 18, 9–24.
- Shopland, D. R., Anderson, C. M., & Burns, D. M. (2006). Association between home smoking restrictions and changes in smoking behaviour among employed women. *Journal of Epidemiology & Community Health*, 60(Suppl. 2), 44–50.
- Siahpush, M., Borland, R., & Scollo, M. (2003). Factors associated with smoking cessation in a national sample of Australians. *Nicotine & Tobacco Research*, 5, 597–602.
- Tong, E. K., Nguyen, T. T., Vittinghoff, E., & Perez-Stable, E. J. (2008). Smoking behaviors among immigrant Asian Americans: Rules for smoke-free homes. *American Journal of Preventive Medicine*, 35, 64–67.
- U.S. Department of Health and Human Services. (2006). *The health consequences of involuntary exposure to tobacco smoke. A report of the surgeon general*. Atlanta, GA: U.S. Department of

Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion Office on Smoking and Health.

Velicer, W. F., Prochaska, J. O., Rossi, J. S., & Snow, M. G. (1992). Assessing outcome in smoking cessation studies. *Psychological Bulletin*, 111, 23–41.

World Health Organization. (2008). *WHO report on the global tobacco epidemic, 2008. The MPOWER package*. Geneva, Switzerland: World Health Organization. Retrieved 26 January

2009, from http://www.who.int/tobacco/global_data/en/index.html

Zhou, X., Nonnemaker, J., Sherrill, B., Gilseman, A. W., Coste, F., & West, R. (2009). Attempts to quit smoking and relapse: Factors associated with success or failure from the ATTEMPT cohort study. *Addictive Behaviors*, 34, 365–373.

Zhu, S. H., Sun, J., Hawkins, S., Pierce, J., & Cummins, S. (2003). A population study of low-rate smokers: Quitting history and instability over time. *Health Psychology*, 22, 245–252.

Copyright of Nicotine & Tobacco Research is the property of Oxford University Press / UK and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.